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Extract from p28 of 4CH1 Specification

Experimental skills

The best way to develop experimental skills is to embed practical investigations in teaching or theory. The development of knowledge and experimental skills can then happen together, leading to secure acquisition of both knowledge and skills.

Our practical investigations are embedded within *2: Chemistry content* as specification points in italics. The skills developed through these and other practicals will be assessed through written examinations.

In the assessment of experimental skills, students may be tested on their ability to:

- solve problems set in a practical context
- apply scientific knowledge and understanding in questions with a practical context
- devise and plan investigations, using scientific knowledge and understanding when selecting appropriate techniques
- demonstrate or describe appropriate experimental and investigative methods, including safe and skilful practical techniques
- make observations and measurements with appropriate precision, record these methodically and present them in appropriate ways
- identify independent, dependent and control variables
- use scientific knowledge and understanding to analyse and interpret data to draw conclusions from experimental activities that are consistent with the evidence
- communicate the findings from experimental activities, using appropriate technical language, relevant calculations and graphs
- assess the reliability of an experimental activity
- evaluate data and methods taking into account factors that affect accuracy and validity.

Appendix 4: Mathematical skills

		B	C	P
1	**Arithmetic and numerical computation**			
A	Recognise and use numbers in decimal form	✓	✓	✓
B	Recognise and use numbers in standard form	✓	✓	✓
C	Use ratios, fractions, percentages, powers and roots	✓	✓	✓
D	Make estimates of the results of simple calculations, without using a calculator	✓		✓
E	Use calculators to handle $\sin x$ and $\sin^{-1} x$, where x is expressed in degrees			✓
2	**Handling data**			
A	Use an appropriate number of significant figures	✓	✓	✓
B	Understand and find the arithmetic mean (average)	✓	✓	✓
C	Construct and interpret bar charts	✓	✓	✓
D	Construct and interpret frequency tables, diagrams and histograms	✓		✓
E	Understand the principles of sampling as applied to scientific data	✓		
F	Understand simple probability	✓	✓	✓
G	Understand the terms mode and median	✓		
H	Use a scatter diagram to identify a pattern or trend between two variables	✓	✓	✓
I	Make order of magnitude calculations	✓	✓	✓
3	**Algebra**			
A	Understand and use the symbols $<$, $>$, $\propto$, $\sim$		✓	✓
B	Change the subject of an equation	✓	✓	✓
C	Substitute numerical values into algebraic equations using appropriate units for physical quantities	✓	✓	✓
D	Solve simple algebraic equations	✓	✓	✓
4	**Graphs**			
A	Translate information between graphical and numerical form	✓	✓	✓
B	Understand that $y = mx + c$ represents a linear relationship		✓	✓
C	Plot two variables (discrete and continuous) from experimental or other data	✓	✓	✓
D	Determine the slope and intercept of a linear graph	✓	✓	✓
E	Understand, draw and use the slope of a tangent to a curve as a measure of rate of change		✓	✓
F	Understand the physical significance of area between a curve and the x-axis, and measure it by counting squares as appropriate			✓

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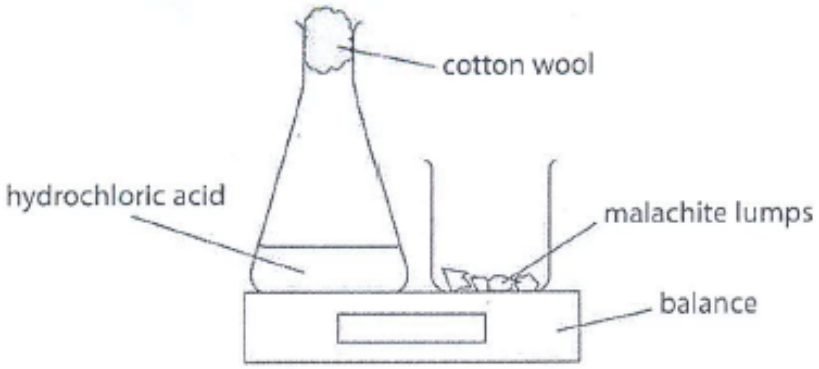
Sample student answer to SAMs question

The copper(II) carbonate in the mineral, malachite, reacts with hydrochloric acid according to this equation.

$$CuCO_3(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(g) + CO_2(g)$$

Some students investigate the effect of changing the concentration of acid on the rate of this reaction. The diagram shows the apparatus they use.



This is the method they use:

- set the balance to zero
- add an excess of malachite lumps to the conical flask and replace the cotton wool
- start a timer and record the balance reading after one minute.

The experiment is repeated using different concentrations of hydrochloric acid. The mass and number of malachite lumps are kept the same in each experiment.

(a) The table shows the results obtained in one series of experiments.

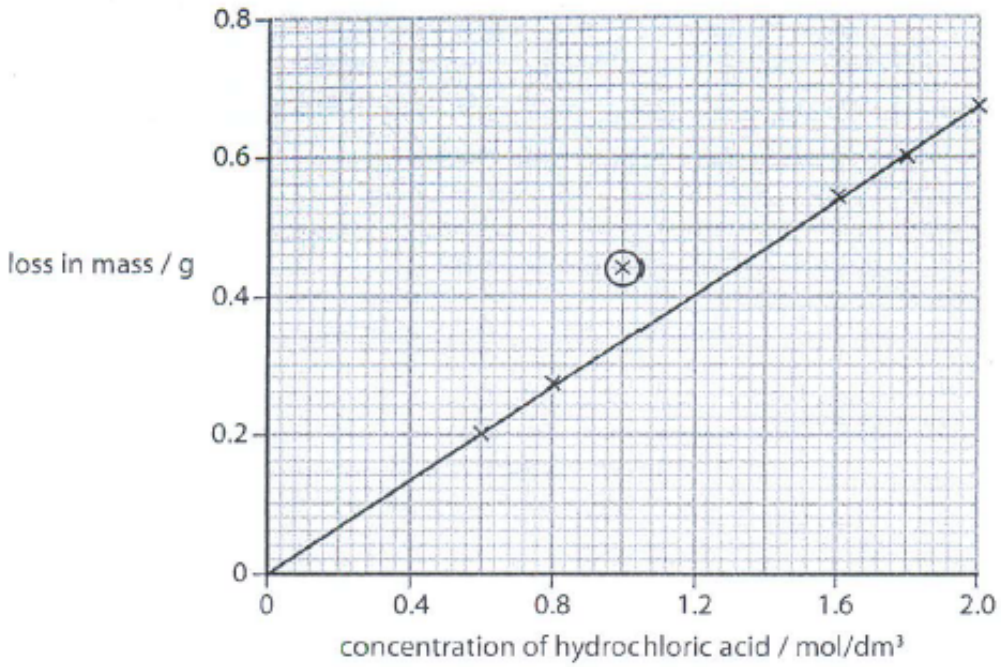
concentration of hydrochloric acid / mol/dm³	0.6	0.8	1.0	1.6	1.8	2.0
balance reading / g	−0.20	−0.27	−0.44	−0.54	−0.60	−0.67

State why the balance readings have negative values.

(1)

To show that the mass decreases.

(b) The graph shows the results of this series of experiments.



The circled point indicates an anomalous result.

(i) Suggest **one** mistake the students could have made to produce this result.

(1)

~~Concentration~~ Timer started quickly.

(ii) State the relationship shown by the graph.

(1)

As the concentration of HCl increases the loss in mass also increases.

(c) Explain why an increase in the concentration of the acid causes an increase in the rate of the reaction. You should use the particle collision theory in your answer.

(2)

Increasing concentrations will increase the number of particles. These particles would now collide more frequently so the number of collisions increase and therefore increasing the rate of reaction.

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Scheme of work example

Week	Content coverage	Learning outcomes	Exemplar activities	Exemplar resources	Which transferable skills are explicitly assessed through examination	Which transferable skills could also be acquired through teaching and delivery
1	**Section 1: Principles of chemistry** (a) States of matter	Students will be assessed on their ability to: 1.1 understand the three states of matter in terms of the arrangement, movement and energy of the particles 1.2 understand the interconversions between the three states of matter in terms of: • the names of the interconversions • how they are achieved • the changes in arrangement, movement and energy of the particles 1.3 understand how the results of experiments involving the dilution of coloured solutions and diffusion of gases can be explained.	**Activity:** • Model particle behaviour in the three states using trays of marbles; draw diagrams of the results. **Demonstrations:** • Diffusion of gases – ammonia and hydrogen chloride (RSC 65). • Bromine diffusing into a gas jar of air. **Class practicals:** • Diffusion in liquids (RSC 27). • Recording a heating curve for water, from ice to boiling point.	Edexcel International GCSE Chemistry Student Book: Pages 1–4 RSC Classic Chemistry Experiments Page 68 RSC Classic Chemistry Demonstrations Page 162	Analysis	Analysis Problem solving